What is claimed is:

1. For use in a fuel cell stack including a stacked series of MEA structures alternating with aligned separator plates, each MEA structure being non-planar and having sufficient rigidity to retain its shape when the stack is placed under sufficient pressure in the stacking direction to maintain physical and electrical contact between each MEA structure and the adjacent separator plate and forming thereby fuel and oxidant channels between the MEA structure and the separator plate;
a separator plate characterized in that such separator plate comprises an electrically insulating substrate overlaid on each of its outer surfaces by a selected pattern of electrically conductive traces, each trace on one surface of the substrate electrically connected to at least one trace on the opposite surface of the substrate by a conductive path, and the pattern of the traces selected so that the traces on each surface of the substrate are in electrical contact with the adjacent MEA structure in the fuel cell stack when the separator plate is aligned with the adjacent MEA structures and stacked in the fuel cell stack.

2. The separator plate defined in claim 1, wherein the conductive path includes at least one via.

Sub A1

3. The separator plate as defined in either of claims 1 or 2, wherein the traces are metallic.

4. The separator plate as claimed in claims 1 - 3 wherein all metallic surfaces are covered with an inert coating.

Sub A1
END.

5. The separator plate as claimed in claims 1, 2 or 4 wherein the MEA structures are mechanically connected to said conductive traces.

6. The separator plate as claimed in any of claims 1 - 4 wherein said traces are formed on and constitute part of a printed circuit board.

7. The separator plate as claimed in claim 6 wherein said separator plate comprises a pair of outer printed circuit boards bearing traces on their outer surfaces and at least one inner circuit board sandwiched between said outer printed circuit boards.

8. The separator plate as claimed in claim 7 wherein conductors on said inner circuit board are connected by vias to at least one electrical device located on at least one of said outer printed circuit boards.

9. The separator plate as claimed in claim 8 wherein said device is electro-mechanical.

10. The separator plate as claimed in claim 8 wherein said device is an ambient condition sensor.

11. The separator plate as claimed in any one of claims 7 to 10 wherein the inner circuit board includes an electrical device connected by vias to conductors on at least one of the outer printed circuit boards.

12. The separator plate as claimed in any one of claims 1 - 11 wherein the said ~~traces are~~ metallic.

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13. The separator plate as claimed in claim 11 wherein the said MEA structure is soldered to the said traces.

Sub A2

14. The separator plate as claimed in any of claims 1 - 13 wherein said substrate is non-planar.

15. The separator plate as claimed in any of claims 1 - 13 wherein said substrate is flexible.

16. The separator plate as claimed in any of claims 1 - 13 wherein the substrate is undulate.

17. The method of converting hydrogen fuel and an oxidant to electrical energy comprising passing the fuel and oxidant through a fuel cell stack including a stacked series of MEA structures alternating with aligned separator plates, each MEA structure being non-planar and having sufficient rigidity to retain its shape when the stack is placed under sufficient pressure in the stacking direction to maintain physical and electrical contact between each MEA structure and the adjacent separator plate and forming thereby fuel and oxidant channels between the MEA structure and the separator plate, a separator plate, characterized in that said separator plate comprises an electrically insulating substrate overlaid on each of its outer surfaces by a selected pattern of electrically conductive traces, each trace on one surface of the substrate electrically connected to at least one trace on the opposite surface of the substrate by a conductive path, and the pattern of the traces selected so that the traces on each surface of the substrate are in electrical contact with the adjacent MEA structure in the fuel cell stack when the separator plate is aligned

with the adjacent MEA structures and stacked in the fuel cell stack.

18. The method as defined in claim 17, wherein the conductive path includes at least one via.

19. The method as defined in either of claims 17 or 18, wherein the traces are metallic.

20. The method as claimed in claims 17 - 19 wherein all metallic surfaces are covered with an inert coating.

21. The method as claimed in claims 17 - 20 wherein the MEA structures are mechanically connected to said conductive traces.

22. The method as claimed in claims 17 - 21 wherein said traces are formed on a printed circuit board.

23. The use of hydrogen fuel and an oxidant to produce electrical energy comprising passing the fuel and oxidant through a fuel cell stack including a stacked series of MEA structures alternating with aligned separator plates, each MEA structure being non-planar and having sufficient rigidity to retain its shape when the stack is placed under sufficient pressure in the stacking direction to maintain physical and electrical contact between each MEA structure and the adjacent separator plate and forming thereby fuel and oxidant channels between the MEA structure and the separator plate, a separator plate, characterized in that said separator plate comprises an electrically insulating substrate overlaid on each of its outer surfaces by a selected pattern of electrically conductive traces, each

trace on one surface of the substrate electrically connected to at least one trace on the opposite surface of the substrate by a conductive path, and the pattern of the traces selected so that the traces on each surface of the substrate are in electrical contact with the adjacent MEA structure in the fuel cell stack when the separator plate is aligned with the adjacent MEA structures and stacked in the fuel cell stack.

24. The use of hydrogen as a fuel gas in fuel cells in a fuel cell stack connectable via an anode terminal and a cathode terminal to an external load, each said fuel cell having:

(i) an MEA structure having a porous anode electrode, a porous cathode electrode, an electrolytic membrane layer disposed between the two electrodes, an anode electro-catalyst layer disposed between the electrolytic membrane layer and the anode electrode, and a cathode electro-catalyst layer disposed between the electrolytic membrane layer and the cathode electrode; and

(ii) two discrete associated reactant-gas impermeable separator layers, one side of one layer in conjunction with the MEA structure providing at least one flowpath of a flow field for hydrogen and one side of the other layer in conjunction with the MEA structure providing at least one flowpath of a flow field for a selected oxidant, the flowpaths are constituted over their greater length by parallel transversely spaced and

longitudinally extending flow channels interconnected in the vicinity of their ends to form the flowpaths;

the MEA structure being installed in the stack between the associated separator layers so that the side of the separator layer that in conjunction with the MEA structure provides flow channels of a flow field for hydrogen faces and is in contact with the anode side of the MEA structure, whilst the side of the separator layer providing flow channels of a flow field for oxidant faces and is in contact with the cathode side of the MEA structure, so that the hydrogen flow channels are closed to form a conduit for supplying hydrogen to the MEA structure and the oxidant flow channels are closed to form a conduit for supplying oxidant to the MEA structure; and

the fuel cells being stacked in sequence, the anode electrode of the fuel cell at one extremity of the stack being electrically connected to the anode terminal, the cathode electrode of the fuel cell at the other extremity of the stack being electrically connected to the cathode terminal, and the anode electrode of each of the other fuel cells in the stack being electrically connected to the cathode electrode of the next adjacent fuel cell,

so that when the anode terminal and cathode terminal are electrically connected through an external load and for each fuel cell hydrogen is supplied to the hydrogen conduit and oxygen is supplied to the oxidant conduit, then in each fuel

cell hydrogen moves from the hydrogen flow field through the anode electrode and is ionized at the anode electro-catalyst layer to yield electrons and hydrogen ions, the hydrogen ions migrate through the electrolytic membrane layer to react with oxygen that has moved from the oxidant flow field through the cathode to the cathode electro-catalyst layer and with electrons that have moved from the anode electrode electrically connected to the cathode electrode, thereby to form water as a reaction product, and a useful current of electrons is thereby produced through the load

characterized in that

separator plate comprises an electrically insulating substrate overlaid on each of its outer surfaces by a selected pattern of electrically conductive traces, each trace on one surface of the substrate electrically connected to at least one trace on the opposite surface of the substrate by a conductive path, and the pattern of the traces selected so that the traces on each surface of the substrate are in electrical contact with the adjacent MEA structure in the fuel cell stack when the separator plate is aligned with the adjacent MEA structures and stacked in the fuel cell stack.

25. The use of hydrogen as defined in claim 24 wherein the conductive path includes at least one via.

26. The use of hydrogen as defined in either of claims 24 or 25, wherein the traces are metallic.

27. The use of hydrogen as claimed in claims 24 - 26 wherein all metallic surfaces are covered with an inert coating.

28. The use of hydrogen as claimed in any of claims 24 - 27 wherein the MEA structures are mechanically connected to said conductive traces.

29. The use of hydrogen as claimed in claims 24 - 28 wherein said traces are formed on a printed circuit board.

30. The use of hydrogen as claimed in claim 29 wherein said separator plate comprises a first two printed circuit boards bearing traces on their outer surfaces and at least one additional circuit board sandwiched between said first two printed circuit boards.

31. The use of hydrogen as claimed in claim 30 wherein conductors on said additional circuit board are connected by vias to devices on the outer surface of at least one of said first printed circuit boards.

32. The use of hydrogen as claimed in claim 31 wherein said devices are electro-mechanical.

33. The use of hydrogen as claimed in claim 31 wherein said devices are ambient condition sensors.

34. The use of hydrogen as claimed in any one of claims 24 - 33 wherein the said traces are metallic.

35. The use of hydrogen as claimed in claim 34 wherein the said MEA structure is soldered to the said traces.